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9 May 2019

Attention: Chester Buller

Dear Chester

Pukekohe Hospital Plantroom - Concept Strengthening

Beca has been engaged to complete strengthening works to the Pukekohe Hospital Plantroom at Pukekohe, Auckland. The purpose of this letter is to provide a summary of our work to date and direction for next steps going forward.

Background

Beca recently completed a number of Initial Seismic Assessments (ISAs) for Counties Manukau Health (CMH) facilities across the Auckland region.

The purpose of an ISA is to act as first step in the overall seismic assessment process. It is a coarse evaluation of a building, that can inform decision makers as to a priority list of buildings. If important decisions need to be made that rely on a buildings seismic status, generally an ISA is followed up with a Detailed Seismic Assessment (DSA).

The Pukekohe Hospital Plantroom Building was scored at 30%*NBS* (IL3) in the ISA. The structure has some particularly undesirable structural features including unreinforced masonry infill frames which have performed poorly in recent earthquakes. Due to its low occupancy and use only as a plant building housing the back-up generator and boilers for the main hospital unit, it has a low life-safety risk, however it’s failure may have consequences on the operational continuity of the main hospital post-earthquake. We recommended a remedial solution was developed for this building to address the potential critical structural weaknesses.

The strengthening design process includes assessment of the existing structure directly and would thus avoid a double up of works.

Structural Description

The building is a single storey structure housing plant equipment critical for the function of the Pukekohe Hospital. The gravity and lateral load resisting system consists of reinforced concrete moment frames. The perimeter frames have URM infills to the frames and a single skin external veneer. There is no evidence of veneer ties but are likely to present (but ineffective). The transverse frames are occasionally infilled with a single layer of brick to form fire separations between different compartments of the building.

The roof is a doubly reinforced concrete slab which ties the frames together.

Summary of Concept Calculations

The critical structural weakness identified in the building is the unreinforced masonry (URM) walls failing out-of-plane. The key failure mechanisms evident in the structure are:

- Out-of-plane failure of the URM veneer 20%*NBS* (IL3)
- Shear failure of the concrete columns due to short-column effects 45%*NBS* (IL3)
- In-plane failure of the URM infill layer 50%*NBS* (IL3)
- Bare frame column flexural strength (URM removed) 80%*NBS* (IL3)

The exterior URM veneer is critical with a score of 20%*NBS* (IL3). There is no evidence of restraint to the top of these veneers, and the wall is thus required to cantilever from ground floor level.

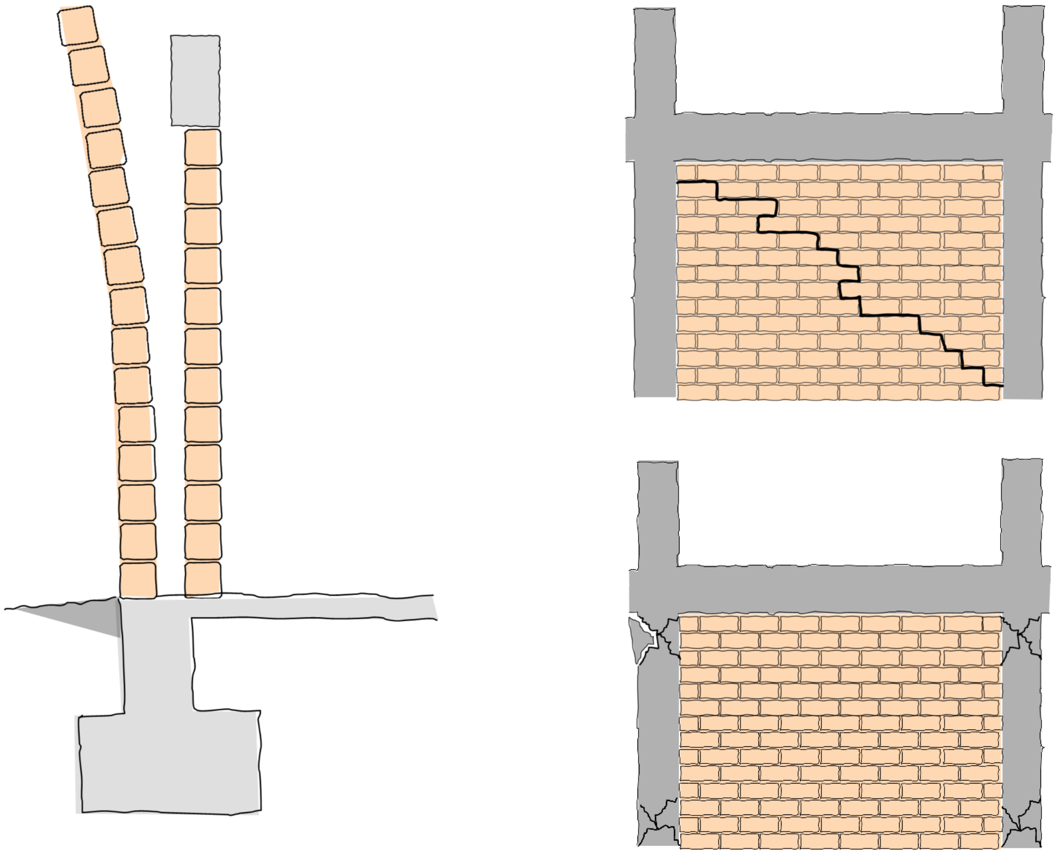


Figure 1: Clockwise - out-of-plane failure of the external veneer, direct tension failure of the URM infill, shear failure of the columns from short column effects

The column shear failure is caused by the development of compression struts in the brick infill. These struts are eccentric to the frame intersection points, forming large shear demands in the columns or beams. As the smaller infills fail progressively in compression, the load is distributed to the larger walls which fail the columns. The column failure in shear is non-ductile and deemed a loss of gravity support to the roof structure.

Our assessment of the existing structure methodology included checking the bare frame, in the scenario that the URM disconnected. Generally the bare frame scored well at 80 %*NBS* (IL3) governed by the flexural capacity of the base of the columns.

Strengthening Options

The building has a number of critical deficiencies, noted in the ISA and confirmed in the intrusive investigations. Based on the ISA results, the building is currently 'Earthquake Prone' (as it is less than 34%NBS (IL3)). The Auckland City Council Earthquake Prone Policy requires that for earthquake prone buildings:

- Are issued an Earthquake Prone Building (EPB) notice which must be displayed in a prominent location in the building. This notice informs the public and residents that the building is of a high risk.
- The building details are added to the national register of earthquake prone buildings
- Strengthening must occur within 35 years from the date of the EPB notice, such that the building is no longer earthquake-prone. If substantial alterations or change of use occurs within the 35 years, then the building must be strengthened at the same time

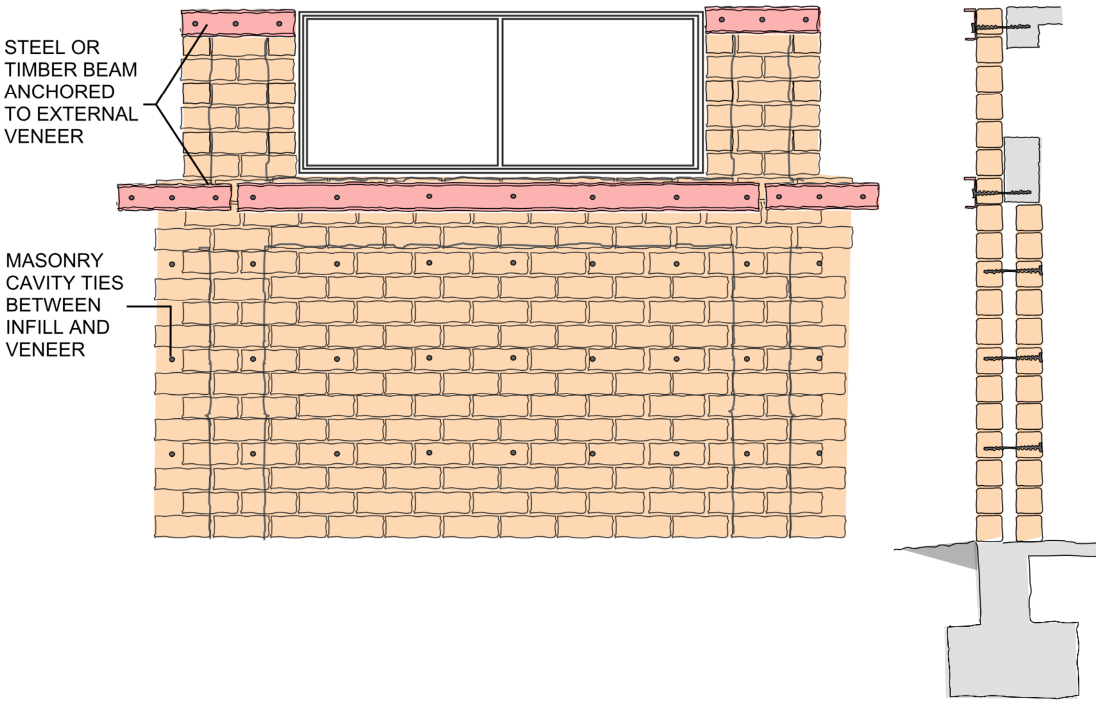
Because the building has limited occupancy, the life safety risk from its failure is relatively small, however the consequence on the operational continuity of the Pukekohe Hospital site is high.

We have developed three options at concept level for strengthening:

Option 1 – Do minimum - Strengthening to >34%NBS

This option would focus on strengthening the URM veneer and infills of the building through restraining the top of the veneer and tying the inner and outer layer of brick together.

The URM walls will have a timber or steel member connected at the top of the wall spanning horizontally between the concrete columns, or connected directly to the frame elements. This member provides restraint, improving the behaviour of the walls out-of-plane. An immediate improvement to approximately 45%*NBS* (IL3) would be expected from this.

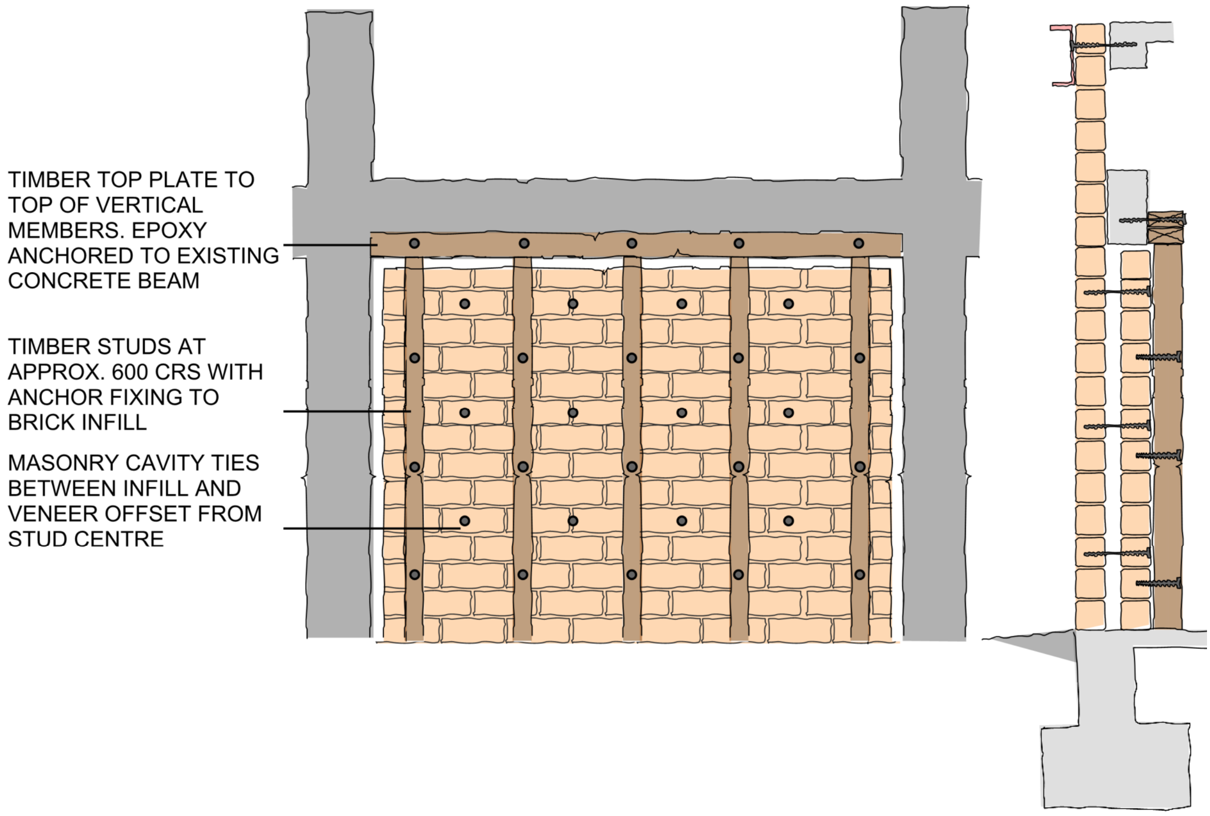


Option 2 – Do more - Strengthening to >67%NBS

This option focusses on strengthening the URM veneer and infills of the building in a more robust manner and reducing the shear demand of the concrete columns.

Timber strong backs at approximately 600 mm centres will be strapped to the internal face of the URM walls with proprietary masonry anchors (Python or Helifix), in combination with new cavity ties between the veneer and infill layers.

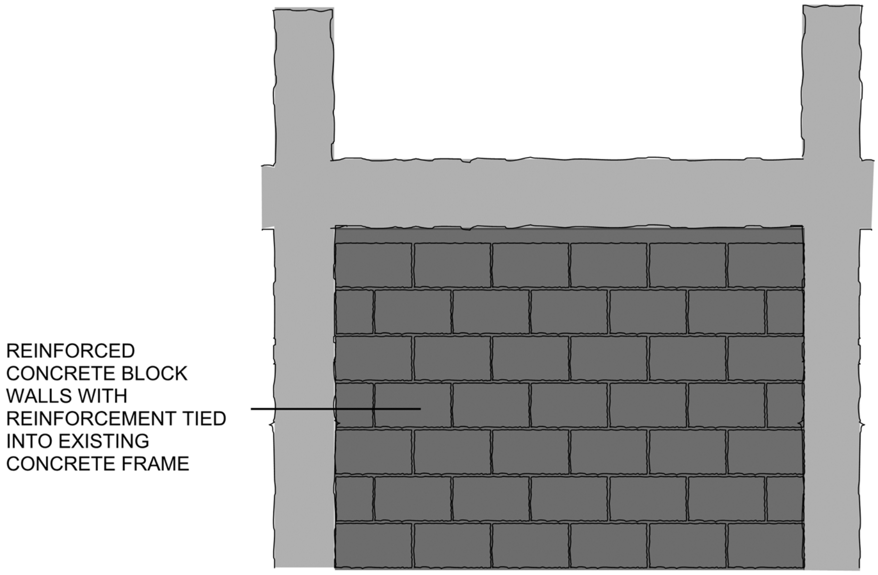
The brick infill layer will be disconnected from their surrounding concrete frames to prevent them 'locking up' under lateral loading. This will likely involve cutting a chase around the infill panel.



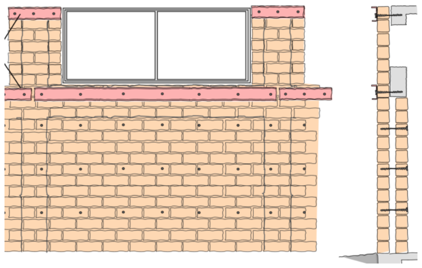
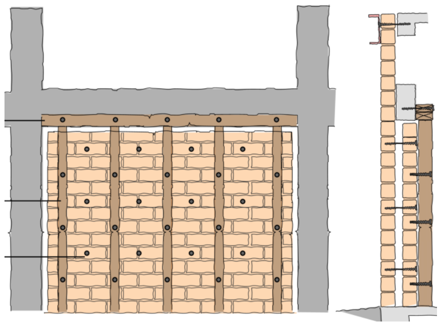
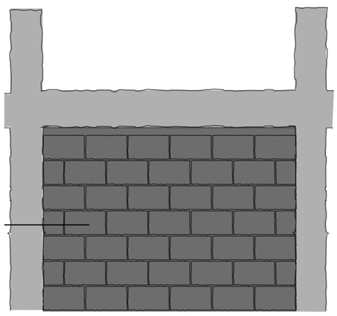
Option 3 – Do most - Strengthening to 100%NBS

This option will remove the URM walls completely, replacing them with a suitable fire-rated lining such as reinforced concrete block, or reinforced concrete shear walls. The replacement cladding / walls will act as the new lateral load resisting system, reducing the demand on the primary concrete frame.

This option will require the removal of the URM walls which will be very intrusive to the operations of the plant room building. Service ducts in the building may need to be re-routed or temporarily supported to allow removal of the brick walls.



The options can be summarised holistically in the table below:

Option No.		Likely Costs	Performance	Disruption
1		$$	👍	👎
2		$$	👍👍	👎
3		$$	👍👍👍	👎👎👎

Next Steps

Beca recommends that Option 2 is adopted as the best balance of improved seismic performance with minimised disruption.

Next steps from here are:

- CMH consider the above options, and confirm acceptance of our recommendation (proceeding with Option 2)
- We will then progress the detailed design and construction deliverable of the option chosen

Yours sincerely

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